

FIELD TRIP

Bighorn Sheep

Theme

Bighorn sheep require a specific habitat in order to survive and thrive.

Utah State Science Core Curriculum Topic

Standard Five: Students will understand that microorganisms range from simple to complex, are found almost everywhere, and are both helpful and harmful.

Objective One: Observe and summarize information about microorganisms.

Objective Two: Demonstrate the skills needed to plan and conduct an experiment to determine a microorganism's requirements in a specific environment.

Objective Three: Identify positive and negative effects of microorganisms and how science has developed positive uses for some microorganisms and overcome the negative effects of others.

Field Trip Location

Any location where students can hike safely for several miles with a likelihood of seeing bighorn sheep. The Lower Porcupine Rim Trail from Highway 128 near Negro Bill Canyon is an excellent choice. This is a winter field trip.

Times

Pre and Post trip lesson are 45 minutes. During the hike each lesson is conducted with the entire class and takes 10-15 minutes.

Science Language Students Should Use

Algae, fungi, microorganism, decomposer, single-celled organism, bacteria, protozoan, producer, hypothesis, experiment, investigation, variable, control, culture

Background

(from Hauke, 1998; U.S. Forest Service, Rocky Mountain Region 1995)

Bighorn sheep are the most highly evolved and most widely distributed of all bovines. They are thought to have evolved in North Africa and migrated to the Americas during the Pleistocene. Desert bighorn sheep live in the Canyonlands of Utah and the deserts of Arizona, New Mexico, and some parts of California and northern Mexico. Desert bighorns are very sensitive to changes in the environment; therefore, they are often referred to as an "indicator species." A healthy, thriving herd of bighorns is indicative of a healthy, thriving ecosystem. An unhealthy herd of bighorns may indicate that the ecosystem is

overused. Recent on-going studies by biologists indicate that for a herd of bighorns to survive long-term, there must be a minimum of 100 animals.

Bighorns are generally a medium gray-brown with white on the rump, backs of legs, and muzzle. This coloring allows them to blend in with the rocky landscape that surrounds their habitat. Desert bighorn depend primarily on their sense of sight to detect danger. They also have good hearing. Their sense of smell is used to distinguish between foods, detect enemies, and identify their young.

Adult desert bighorns are 30-39 inches tall at

the shoulders. Males are normally larger than females. An adult male, called a ram, averages 160 to 200 pounds or more early in the summer. Rams have a thick, blocky appearance. They have thick necks and large curled horns that measure up to 30 to 40 inches along the outside of the curl. An adult female bighorn, called an ewe, averages 105 pounds. Ewes are more slender than males; they have especially slender necks. Ewes have small horns measuring 10 to 13 inches long. Wildlife managers categorize bighorns into four size classes, using the curl of the horn to determine the class. Rams recognize their elders by the size of their horns; dominant sheep having the biggest horns. Average life expectancy is 10-12 years.

Desert bighorns need food, water, escape terrain, and space. Their first food preference is Indian ricegrass. They also browse brush and plants with woody stems, especially blackbrush, and sometimes ephedra. They also feed on a few forbs (green leafy plants other than grasses). Water is the primary limiting factor for desert bighorn. Rams can go a long time without drinking; getting all the water they need from their food. But ewes, especially during lactation, require a regular source of water. Sources of water include streams, potholes, dew, springs, and water found in food. Desert bighorn prefer open space around their drinking holes so they can see approaching threats. They won't venture more than a few hundred meters from their escape terrain to get water.

Bighorns use escape terrain to get away from predators, since few animals are able to move as quickly as bighorns through such rugged terrain. Bighorns do not run long distances, but escape their enemies by climbing and hiding in this rugged terrain. Caves and the shelter of trees are used during poor weather and to escape aircraft and eagles. Predators of bighorns are coyotes (most common), eagles (feed on lambs), gray foxes, bobcats, and mountain lions. Predation is not a primary cause of death for bighorns, due to their escape terrain and the variety of wildlife that these predators prey upon.

The area across highway 191 from the Atlas Tailings pile has all the components of good desert bighorn sheep habitat. It has an open space for the animals to graze and spot predators, and it is close to steep rocky escape terrain. Unfortunately, cars hit approximately one sheep a year, a danger the sheep are not genetically adapted to avoid.

Ewes have their first lambs at about age three,

and produce one, rarely two, lambs each year. Lambs are born in the spring and gain weight quickly. By two to three months of age they have sleek, well-proportioned bodies. At six months of age they are weaned from their mothers. Lambs are usually born in rough terrain with caves or overhanging rocks for protection from predators and weather. Nighttime bedding grounds are often near the top of ridges or long spurs, from which ewes can see much territory. Locations like this allow for a quick escape over the ridge or down the mountain.

Desert bighorns have a "nursery system." Two ewes remain with all of the lambs on the edge of escape terrain. The other ewes in the band move into open areas to feed on succulent spring plants. Lambs are obedient to the ewes in charge. The feeding ewes return to the lambs on occasion to nurse and exchange places with the nursery ewes. As lambs become older and begin to eat solid foods, they begin to travel with their mothers.

Cause of death can be hard to determine in bighorns. Causes include diseases caused by bacteria and viruses, parasites, tumors, and mineral and dietary deficiencies, as well as accidents, poisonous plants, and extreme climate conditions. Often several factors interact to cause death. Domestic sheep are the biggest threat to bighorn. They eat similar foods and carry parasites and diseases detrimental to bighorn. Bighorns are known for precipitous herd die-offs. Investigations have attributed the causes to parasites and diseases. Recent management efforts to separate domestic sheep from bighorn range have resulted in decreased die-off. Ear mites cause the most common disease among the bighorn of southeastern Utah. These mites spread down from the head, cause skin problems, and weaken the sheep, making them more likely to succumb to other stresses.

When settlers arrived in the western U.S., there were probably 1.5 to 2 million desert bighorns. In 1975, there were only about 1000 in the state of Utah. The drop can probably be attributed to diseases brought in by European domestic sheep. In the 1970s, grazing leases within Canyonlands and Arches national parks expired. Around this time, the BLM also ended sheep grazing leases on BLM lands near the bighorn range in the parks. Consequently, the populations of bighorn sheep in this area have vastly increased. When Canyonlands was established in 1964, there were 80 bighorn living

in the park. Most bighorn were in the Island in the Sky District; a few were in the Needles District. Now, Island in the Sky is home to approximately 350 bighorn. Some Island in the Sky sheep were transplanted to produce the Arches herd, now 125 head, and the Maze herd, now 50-100 head. The population of the Needles herd dropped from 125 to 15 in the mid 1980s, after domestic sheep were grazed just outside the park. The domestic sheep were removed and the bighorn population has since rebounded to 50 head.

Individual bighorns can become physically run-down or nervous if harassed by other bighorns, large animals, or people, which can contribute to improper diet. Bighorns are sensitive to people on foot, especially in areas where people seldom travel. Bighorns seem less bothered by people on bikes or in cars, even when vehicles stop for a look.

Bighorns commonly use pathways dictated by the topography of the land. The Colorado and Green rivers provide natural barriers that divide herds, and prevent the spread of disease. Unfortunately, roadways, fences, and canals built by people tend to cross bighorn travel routes. This can limit movement from feeding grounds to water, causing herds to become isolated. Inbreeding can occur in smaller herds, which weakens the immunity and health of the herds and creates a serious concern for the

herd's longevity. Fortunately, much of the land occupied by bighorn is under the protection of government agencies. These agencies are attempting to implement new regulations on bighorn range that will benefit these animals.

Bighorn sheep at Arches National Park



PRE-TRIP ACTIVITY

A Bighorn Adventure

Objectives

Students will be able to:

- a. Describe the habitat of desert bighorn sheep.
- b. Name some adaptations that help desert bighorn to survive.

Materials

“Ovisopoly” board game, with game pieces, cards, and dice; bighorn skull; bighorn and mule deer track casts and scat; bighorn pelt.

PROCEDURE

1) Tell the students that on their winter field trip, they are going to be learning about the habitat of one of the large animals that lives in Arches National Park and other places around Moab. Tell students that you will give clues as to the animal’s identity, and when they think they know, they should raise their hands. Give clues until the whole class has raised their hands. Features such as brown fur, white butts, split hooves, and curved horns are good clues, as are adaptations such as diet, jumping and rock-climbing skills, and survival activities. You can use a riddle, such as, “I live in a desert garden, I

can go for a week without water, and I regularly survive head-on collisions. Who am I? “

2) Tell the students that they are going to be playing a board game about the survival of the bighorn sheep. Give instructions and divide the class into groups of four. Stress that they must read the cards aloud to the other players! Circulate among the 4 groups and discuss objects such as a bighorn skull and bighorn and mule deer track casts and scat samples as the students are playing the game, and make sure they’re reading the cards aloud.

3) Tell the students that the upcoming field trip will involve a fairly strenuous hike and that they need to be prepared to hike uphill. Explain that the trail may be snow-packed in places, so it is very important that all students wear shoes with good traction. Review appropriate behavior when near steep drop-offs. Emphasize the importance of bringing the right clothes, including layers, hat, mittens, and warm socks. Tell students that a thermos with hot soup or a hot beverage for lunch will help to keep them warm. Encourage students that own binoculars to bring them.

Following tracks at the tracking station



Ovisopoly Game Board



Ovisopoly Game Cards - Ewes

It's fall and you find a mate

Move ahead 2 tracks.

You find a big pothole filled with water from a recent rainstorm.

Move ahead 2 spaces.

You are 3 years old and this spring you give birth to your first lamb, a 9 pound female.

Move ahead 4 tracks.

Your ears become infested with mites. As a result, you cannot hear a cougar stalking you and are unable to get away in time.

Go back 5 tracks.

You and the other ewes in your family group find good places to forage for food for the summer.

Move ahead 3 tracks.

Your excellent eyesight allows you to see a human coming from almost a mile away. You climb the rocky slope until you feel safe.

Move ahead 2 tracks.

Ovisopoly Game Cards - Ewes

You are alarmed by a loud noise below you. You find your lamb and lead him to a safe place.

Move ahead 1 track.

Five new houses are built in your territory. Loss of space makes you stressed and you become sick.

Go back 2 tracks.

After a week without water, you find a big pothole to drink from.

Move ahead 2 spaces.

You find shelter in a cave so your lamb will be safe from a golden eagle flying overhead.

Move ahead 3 tracks.

You become nervous and highstrung because of many humans and cars in your range. You and your group are forced move to another area.

Go back 1 track.

A sheep farmer lets his herd of domesticated sheep into your territory. Many of your herd catch diseases and your population crashes!

Move back 5 tracks.

Ovisopoly Game Cards - Ewes

You run into a biologist's net and you are caught! Humans move you by helicopter to another territory and you begin a new herd where bighorns once lived.

Move ahead 4 spaces.

After domesticated sheep are moved out of your territory, the population of your herd grows from 20 to 200 in ten years.

Move ahead 5 spaces.

Biologists catch you in a net, place a radio collar around your neck, and release you. They can now track your location and learn about your habits.

Move ahead 1 space.

Ovisopoly Game Cards - Rams

You catch a disease from domesticated sheep and become too weak to live through the winter.

Go back to start.

A biologist catches you in a net and puts a radio collar on you so she can learn more about bighorn health and behavior.

Move ahead 2 spaces.

You find good food sources and by early summer weigh almost 200 pounds!

Move ahead 3 spaces.

During the fall rut (mating time) you butt horns with another ram until he gives up in exhaustion, so you have your choice of mates.

Move ahead 5 spaces.

You and several other bighorn sheep are transported by helicopter to a National Park where you begin a new herd in a protected habitat.

Move ahead 4 spaces.

You lose a head-butting contest and will not mate this year.

Go back 3 spaces.

Ovisopoly Game Cards - Rams

A poacher shoots you illegally for your magnificent horns.

Go back to start.

You outrun a cougar who's chasing you across a rocky hillside at 30 miles per hour!

Move ahead 3 spaces.

In captivity, you learn to shake nuts from an almond tree by butting it with your head!

Move ahead 2 spaces.

A two-year drought makes it hard for you to find enough food. You are forced to move for a better habitat.

Move ahead 1 space.

Frightened by a predator, you run blindly and fall off a cliff, breaking your leg.

Go back 4 spaces.

You spend the cool evening playing with other lambs, leaping and scampering around on the cliffs.

Move ahead 2 spaces.

Ovisopoly Game Cards - Rams

Wildlife managers install a “guzzler”, (which is like a water fountain for bighorn sheep) in your territory, so you and your lamb have enough water to drink all summer.

Move ahead 4 spaces.

One hunting permit for a bighorn ram is auctioned off for \$55,000 this year! This pays for wildlife experts to study and manage your herd for the whole year.

Move ahead 4 spaces.

By counting the rings on your massive horns, a biologist can tell that you are 20 years old, which is very old for a bighorn sheep.

Move ahead 3 spaces.

Fewer deer this year mean that cougars prey on your herd more than usual, so your population drops.

Go back 3 spaces.

Hike the Habitat: Bighorn Sheep, Plants, Tracks and Birds

Objectives

Students will be able to:

- Describe the habitat of desert bighorn sheep.
- Name two plants that desert bighorns eat.
- Name two other creatures that share the habitat of desert bighorn sheep.

Materials

Binoculars; *Track Pattern Cards*, each with a description and drawings of one basic track pattern, laminated construction paper “tracks”, at least two copies of *Animal Tracks of the Southwest* (Stall 1990) or other tracking field guides; “Who Am I?” plant riddles; small poster with the anatomy of a bird on one side and the names of seven birds to be discussed on the other; pictures of seven commonly-seen birds; bright clothing for human bird dress-up; bird field guide; maps of area.

Note

If the sheep are grazing along the highway, stop the bus and spend some time reviewing bighorn characteristics, adaptations, and difficulties.

PROCEDURE

1) Tell the students that we will be starting on a strenuous hike. Remind them of safety concerns on steep slopes and potentially icy or snowy trails, distribute warm clothes, and confirm that everyone has drinking water. Explain that there will be an instructor at the beginning and at the end of the line of hikers, and that it's ok to spread out. However, we will stop at a number of stations and wait for everyone. Explain that each station will involve a short talk or activity relating to bighorn sheep and the things that share their habitat. Ask them to think about what they know about bighorn sheep and about where they might be likely to see them.

2) **Bighorn Review Station (This information can be covered on the bus if bighorns are viewed from the bus.):** Ask the students what they remember about bighorn sheep from the pre-trip. Discuss topics not mentioned, such as water needs, lifespan, predators, management issues, bighorn rehabilitation and relocation, migration routes and barriers, and herd size. Discuss likely areas to see sheep on this hike. Go over what to look for, including movement and color. Demonstrate the use of binoculars, including focusing and finding the spot they want to look at.

Challenge Question: Why do wildlife management officials have to spend large amounts of money to move bighorn sheep?

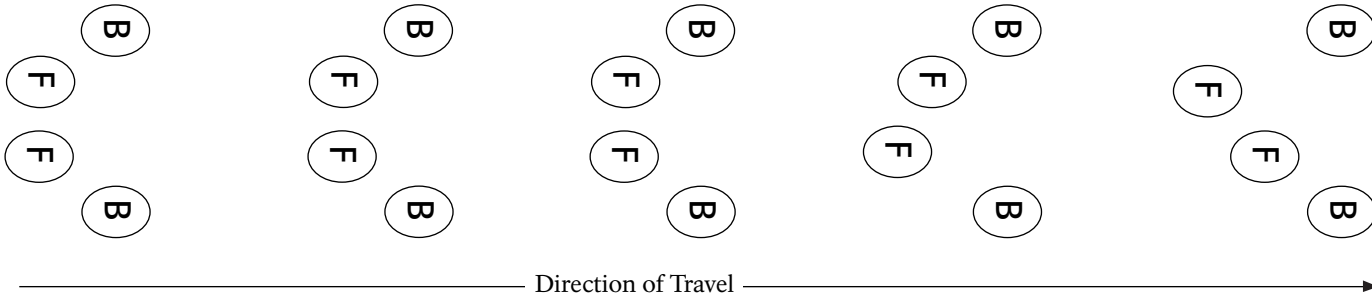
3) **Tracking Station:** Introduce tracking, and include the following information: Though seeing many animals out during the day is uncommon, seeing tracks is easy. The sands common in southeastern Utah often show tracks in astonishing detail. Looking at tracks can tell you what sorts of animals were in an area, as well as how they were moving. Sometimes, tracks tell you what the animals were doing and if they were interacting with each other. You may examine the track itself, including its size and shape, whether a hoof made it or how many pads the foot had, and whether there are claw marks or fur imprints. How far apart tracks occur can often give you an idea of an animal's size. Habitat should be kept in mind, as it gives clues to the animals likely to be in an area. Tell students that another aspect of tracking is looking at patterns, as they reflect how different animals move. Ask students to list ways animals move (e.g., walk, hop, jump, slither). Tell students that the ways that four-legged animals move can be classified into a few basic types. Have a volunteer student read the paragraph from one of the three **Track Pattern Cards**. Use rocks or cardboard tracks to replicate the pattern. Explain and/or demonstrate how the animal moved, and, if appropriate, have a few students try to replicate the movement. Repeat for the other two **Track Pattern Cards**. Discuss how to recognize snake, bird, and lizard tracks. Insect tracks can often be seen in sand; they might hop or walk. On the next part of the hike, ask students to look for different types of patterns, and see if they can find one of the patterns on very different scales. It's important to remind them not to step on tracks or others won't be able to see them!

Challenge: Find a walking or hopping track pattern, and be the first to show it to an instructor. Perhaps assign a different pattern to each instructor. Hint: Your chances are better if you hike near an instructor.

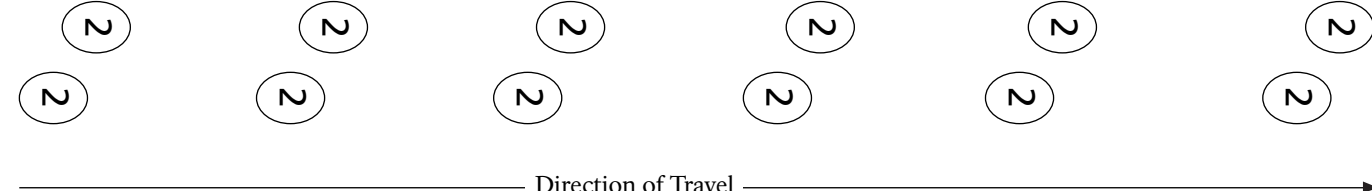
4) **Lunch and Plant Station:** Ask the students if any of them recognize the plants along the trail. Point out or show pictures, and tell a little about eight plants they might see: Ricegrass, Blackbrush, Dwarf Mountain Mahogany, Pinyon, Juniper, Rabbitbrush, Sagebrush and




Track Pattern Cards

JUMPING, HOPPING AND BOUNDING



JUMPING OR HOPPING



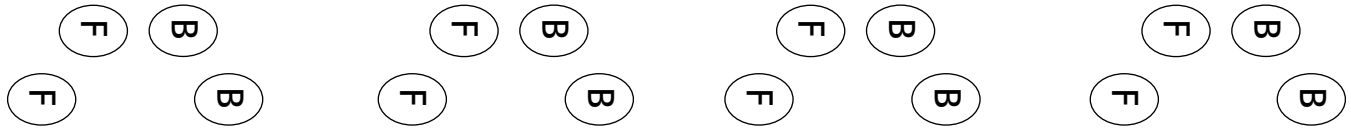
KEY:  Back foot track on top of front foot track  Back foot track  Front foot track

Many animals hop or jump occasionally. Rabbits, squirrels and some mice move this way most of the time. Their back legs and feet have more muscle for pushing off, and are wider apart than their front feet. Their back feet land one beside the other. Their two front feet may land beside each other, or one may land before the other one.

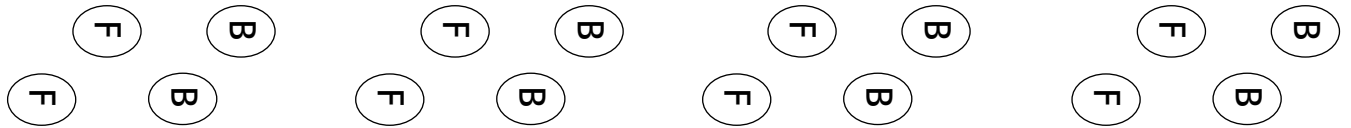
When weasels jump, their back feet land in their front feet tracks. This type of jumping is called bounding.

Track Pattern Cards

GALLOPING



OR



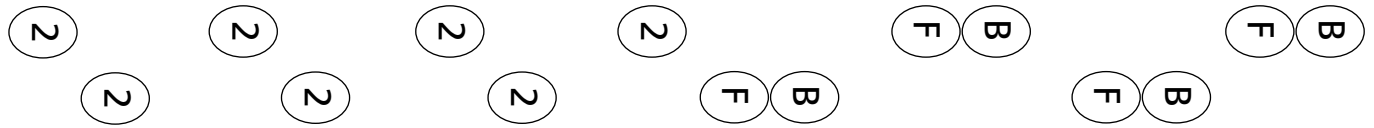
————— Direction of Travel —————→

KEY: (B) Back foot track (F) Front foot track

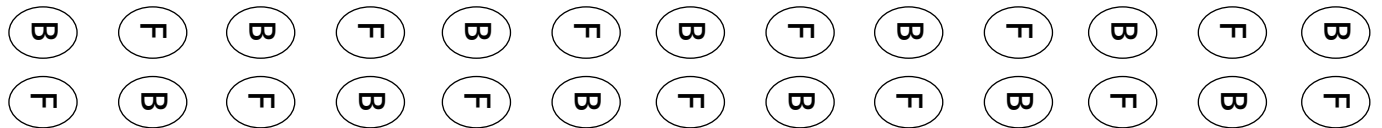
Horses gallop when they want to get somewhere fast. So do deer, antelope, dogs, cats and even bear. There are two different orders in which animals move their feet when they gallop. In both cases, their back feet give the biggest push and land in front of their front feet.

Track Pattern Cards

WALKING, SPEEDING UP TO TROTTING



WADDLING



Direction of Travel →

KEY: Back foot track on top of front foot track Back foot track Front foot track

Most land animals can walk and, if they want to go a little faster, trot. Deer, elk, dogs, cats and some mice move this way most of the time. Slower, heavier, low-to-the-ground animals like porcupines and raccoons have a walking pattern called waddling.

Mormon Tea. Tell students that you will read a series of “Who am I?” **Plant Riddles** about the plants we just discussed. Ask them to raise their hand when they know the answer. After reading each riddle, pick a student to name the plant and see if they can point it out.

Challenge: Find and point out a piñon tree.

5) Bird Station (at the trailhead if there is time): Using the bird poster, introduce birdwatching and the anatomy of a bird. (One instructor should dress up like a bird in a hidden nearby location during this introduction.) The human bird should appear briefly on cue, imitating a bird behavior, such as tail bobbing. Once hidden, ask students what field marks they noticed. Ask them if they noticed any distinctive behavior that might help us to identify the bird. Have the human bird reappear for a little while longer this time. Once again, discuss field marks and behavior. Introduce seven birds that might be seen at this location in the winter, including golden and bald eagles, peregrine falcons, common ravens, mallard ducks, Canada geese, and dark-eyed juncos. Show photographs of each. Tell students about the Audubon Christmas Bird Count, and describe the area that is counted around Moab each year (Moab, all of Spanish Valley, Sand Flats, Castle Valley, the wetlands, along the river, Mill Creek, Behind the Rocks).

Challenge Question: Have students raise hands to guess which of the seven birds was most common in the latest Christmas Bird Count. (Christmas Bird Count numbers for December 16, 2000 are: 827 juncos, 170 mallard ducks, 167 ravens, 15 Canada geese, 10 golden eagles, 1 peregrine falcon. No bald eagles were seen in this year’s count, though they are seen most years.)

Studying animal tracks



"WHO AM I?" PLANT RIDDLES

- I send up fresh green shoots in patches of cryptobiotic soil every spring,
- But I turn brown by late summer.
- Ancestors of Native Americans collected my tiny seeds for food.
- I am a favorite food of desert bighorn sheep living near Moab.

Who am I? Indian Ricegrass.

- I have small gray-green leaves, which prevent moisture loss in the hot summer.
- My thick woody branches are opposite each other.
- I am another favorite food of bighorn sheep.
- I have yellow flowers in the spring.
- I get my name because my stems look black in the rain.

Who am I? Blackbrush.

- I grow largest and thickest in disturbed areas, and I can be five to seven feet tall.
- My bright yellow flowers can be used to make golden dye for cloth.
- Rabbits and other small critters hide under my branches to escape predators.
- Often I am covered with insect galls that look like cotton balls.

Who am I? Rabbitbrush.

- I survive in the desert by photosynthesizing in my stems instead of in leaves.
- Desert bighorns eat me.
- I look like an upside-down broom.
- Early pioneers used to make tea from my stems.
- The drug Sudafed comes from my cousin.

Who am I? Mormon Tea.

- I have small dark green leaves with a waxy coating to prevent water loss.
- My leaves occasionally look rusty.
- I have tiny pink flowers in the spring.
- My woody branches are alternate.
- From a distance, I am often mistaken for blackbrush.

Who am I? (Dwarf or Curlleaf) Mountain Mahogany.

- I am a tree, and can live 300 - 500 years.
- I am one of the most common evergreen trees in Canyon Country
- My short needles grow in twos.
- My pitch is used by some Native Americans to waterproof baskets and pots.
- My nuts are tasty and full of protein, but only grow abundantly every 3 to 7 years.

Who am I? Pinyon Pine.

- My leaves have waxy scales and my bark peels off in long strips.
- I am another common evergreen tree of Canyon Country.
- Humans can use my blue berries for flavoring or tea.
- I can live to be 300 - 500 years old.

Who am I? Juniper.

POST-TRIP ACTIVITY

Murder Ewe Wrote

(adapted from U.S. Forest Service, Rocky Mountain Region, 189-195)

Objectives

Students will:

- a. Analyze information about a complicated wildlife population event, and apply the analysis to answering a number of questions.
- b. Name three factors that can lead to a crash in a bighorn sheep population.

Materials

Six each of: *Mystery Story* and *Mystery Questions* (copied back-to-back), clues, and hint cards.

PROCEDURE

1) Ask students to share information about bighorn sheep they learned during the field trip, and supplement. Tell the students that the biology and life history of any wildlife species, and how it interacts in its ecosystem, is incredibly complex.

2) Explain that wildlife biologists and land managers attempt to understand these complexities, but often learn the most from what might be considered disasters, such as big die-offs in a population. Explain that you have a story about an apparently mysterious die-off in a herd of Rocky Mountain bighorn sheep. (Though fictional, this story is a compilation of several real-life events.) Explain that desert bighorns face some similar challenges and some different ones. Ask students to listen carefully, as they will be working in groups and solving the mystery later. Read the *Mystery Story* as a class.

3) Tell the students that to solve this mystery, they will need to answer a number of questions. Read the *Mystery Questions* to the class. Explain that each group will have a copy of the story and questions, as well as five clues to help them answer the questions.

4) Divide students into groups of about four, and instruct that one student in each group needs to have a pencil and paper in order to record the answers to the questions. (This duty may rotate.) Explain that the answers to questions 1-9 are found either in the story or in one of the clues. Explain that question 10 requires putting together all of the information. Tell them not to attempt this question until they have finished answering the others. Tell students that each group will get one hint card, which may be traded in for the location of the answer

to one question. Suggest that if they are stuck on a question, they skip it and move on to the next one, using the hint card as a last resort. Explain that they may find the answer they are looking for later or may come across a harder question. Pass out a set of *Mystery Story/Mystery Questions*, clues, and a hint card to each group. Give the students enough time so that most groups finish with questions 1-9.

5) Call on different groups to present their answers. As a class, discuss the answer to question #10. Review the steps wildlife managers took once they finally figured out the causes of the die-off, and discuss what steps they could take in the future to prevent or limit similar events. Discuss differing challenges of the desert bighorn sheep near Moab.

MYSTERY STORY OF THE TAYLOR CANYON ROCKY MOUNTAIN BIGHORN SHEEP HERD

(from U.S. Forest Service, Rocky Mountain Region, 192)

The Taylor Canyon bighorn sheep herd lives in a typical Rocky Mountain ecosystem characterized by rugged mountains, canyons, and small, grassy valleys. Valley bottoms are privately owned; most of the other higher terrain is public land.

During the summer months, wildlife biologists estimated the bighorn sheep herd to number 250. This was the largest herd size in many years. Numerous ewes with lambs were sighted in alpine meadows and scattered bands of rams were noted at higher elevations.

Late-season (December) elk hunters in the area reported lots of bighorns. All appeared healthy, although there seemed to be few lambs. Many male rams were observed fighting other male rams for females with whom to mate.

January brought heavy snows and cold weather. Snow depths were up to five feet and mid-day temperatures were as low as -20 degrees (F).

On January 18, wildlife biologists noted ski tourists pulled off the highway taking pictures

of the bighorn sheep. One tourist came within ten feet of a ram. Bitter cold and deep snows persisted.

Ranchers noted that many of the bighorns appeared to be tired, ragged, and weak. The bighorns staggered and mucous discharge was observed coming from their mouths and noses. Many bighorns were coughing. On January 21, one rancher notified wildlife officials.

Two days later, wildlife officers found eight dead rams and two extremely sick ewes. Two dead bighorns were sent to a university lab where autopsies were performed to determine the cause of death.

On February 5, ground surveys and aerial flyovers found only 48 bighorn sheep alive. Some of the remaining bighorn sheep were netted and medically treated. Food was brought in. No more deaths occurred.

What caused this dramatic population crash?

MYSTERY QUESTIONS

(adapted from U.S. Forest Service, Rocky Mountain Region, 192)

1. How many Taylor Canyon bighorn sheep died between the summer and February 5th?
2. What unusual wildlife behavior could have been a clue that the sheep were not healthy?
3. Why did so many of the herd die in such a short period of time (January through February 5th)?
4. Why did the rams die earlier than the ewes?
5. Why were there only a few lambs in December, though there were many in the summer?
6. How do bighorn sheep get lungworms? What is the lifecycle of the lungworm?
7. What is the relationship between the pneumonia bacteria and the lungworm?
8. What human activities increased winter crowding and decreased winter food supplies for the Taylor Canyon bighorn sheep herd?
9. What conditions make it more likely that a bighorn sheep will get sick with pneumonia/lungworm?
10. Name as many factors as you can that caused the die-off of the Taylor Canyon herd.

MYSTERY CLUES

(adapted from U.S. Forest Service, Rocky Mountain Region, 193-195)

A. Usually only unhealthy wild animals allow humans to get close to them.

B. Young or physically stressed bighorn sheep are more likely to get diseases than healthy unstressed sheep. Stresses may include a difficult winter, loss of habitat, fighting for mates or running from machines. Stressful conditions will kill off young sheep first, and an observer might notice a lack of lambs in a band.

C. Diseases spread easily among sheep herds in crowded conditions. In wintertime bighorns tend to be more crowded than in summer. During summer, bighorn sheep stay at high elevations on public lands, eating nutritious alpine plants. When winter snows arrive, they typically move down into the valleys and canyons, where there are more private lands, more people, and more cattle. Private lands in Taylor Canyon are grazed in the summer by large numbers of cattle, leaving fewer plants for the bighorn. During this summer one rancher sold some of his valley land to a developer, who has begun building homes. By the time winter arrived there were fewer places to graze, with less food available on them.

D. Bighorn sheep, like people, can't fight off diseases as well when they are tired. Several factors caused the Taylor Canyon bighorns to use up extra energy and become tired this fall and winter:

*Their breeding season is November and December. Rams fight to breed with ewes. Because of the energy spent on fighting, rams have less energy leftover for a long, hard winter than ewes do.

*The elk hunters in December were riding snowmobiles. These loud machines easily spook bighorn, causing them to use up energy getting away.

*During cold weather, bighorn sheep spend lots of energy trying to stay warm. In mid-January temperatures were -20 at midday.

*When the ground is covered with snow, bighorns must paw through the snow to find grass to eat. This is tiring. Five feet of snow were on the ground in January.

*Deep snow makes walking more tiring for bighorns. It also makes bighorn herds congregate closer together, on a few pieces of bare ground or areas with the least snow. When animals are closer together, disease is more likely to spread throughout the herd.

E. Autopsies of Taylor Canyon bighorn sheep showed that dead bighorns carried both pneumonia-causing bacteria and parasites called lungworms. Even healthy bighorn sheep have the bacteria. But the bacteria only cause disease when there are open sores in the lungs. Lungworms cause these open sores in the lungs.

The larval stage of the lungworm is found in small land snails that bighorns sometimes eat by accident when grazing. The larval stage of the lungworm then travels from the bighorn's stomach to its lungs, and causes the open sores. Once in the lungs, the lungworms mate and lay eggs. The pneumonia bacteria takes hold in the sores, and cause the bighorn's lungs to fill up with mucous. The bighorn tries to cough the mucous out. When the lungworm eggs hatch, the young larvae are coughed up and swallowed, leading to more sores and mucous in the lungs.

ANSWERS FOUND IN CORRESPONDING LOCATIONS

1: story

2: A

3: D

4: D

5: B

6: E

7: E

8: C

9: B, C, D

10: Story and all clues

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